Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Carrier Current Systems, Including Broadband Over Power Line Systems	)	ET Docket No. 03-104
	)	
Amendment of Part 15 Regarding New Requirements and Measurement Guidelines for Access Broadband over Power Line Systems	)	ET Docket No. 04-37

COMMENTS OF THE BOEING COMPANY

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SUMMARY

Aeronautical High Frequency ("HF") spectrum provides essential, safety-of-life communications services for the aviation industry. Aeronautical HF networks are a primary, and beyond line-of-sight, generally the only means of communications with aircraft flying over ocean routes, polar regions, some developing countries and other remote regions of the world. Aeronautical HF communications spectrum is also used extensively within the continental United States for airborne and ground testing of new and modified commercial and governmental aircraft and aircraft components.

The HF frequency band is uniquely suited for ensuring essential communications with aircraft because HF signals propagate over very long distances. HF transmissions refract in the ionosphere, permitting them to travel far beyond the horizon. These optimal propagation characteristics, however, also extend the reach of unwanted emissions, permitting them to aggregate and increase the noise floor, heightening concerns about harmful interference.

Aeronautical HF communications networks regularly exchange transmissions over thousands of miles using signals that are marginally above the noise floor. To close air-to-ground communications links, HF ground stations operate with highly sensitive, omnidirectional and/or directional receive antennas, which are extremely susceptible to harmful interference and disruptions to air-to-ground communications.

Because of the critical importance of aeronautical HF communications services, the Commission must ensure that Access Broadband over Power Line ("Access BPL") systems do not cause harmful interference to aeronautical HF networks. Alternatively, Access BPL networks must not be permitted to operate in the less than 3 MHz of spectrum allocated to commercial aeronautical and flight test services between 2 and 30 MHz.

The *NPRM* failed to acknowledge the potential for harmful interference into essential, safety-of-life aeronautical HF communications services. The *NPRM* also failed to propose interference mitigation and prevention techniques that would be adequate to protect critical aeronautical HF communications. The Commission should therefore carefully investigate these issues before adopting any rules authorizing the operation of Access BPL networks in spectrum allocated to aeronautical HF communications services.

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The Boeing Company ("Boeing"), by its attorneys, hereby provides these comments in response to the Commission's Notice of Proposed Rulemaking ("*NPRM*") in the above-captioned proceeding.

I. INTRODUCTION

Boeing is providing these comments in its role as a global leader in the design and manufacture of commercial and military aircraft. Boeing relies on spectrum resources for a variety of manufacturing, operation and flight test purposes. Boeing holds more than six hundred FCC authorizations, covering more than fourteen thousand licensed emitters and operating in more than four thousand frequency segments.

One of Boeing's "mission critical" spectrum resources is High Frequency ("HF") aeronautical communications spectrum. Boeing uses aeronautical HF communications networks in the design, testing, operation and delivery of new and modified aircraft and aircraft components. Aeronautical HF communications are also used by the aviation industry worldwide to ensure the safety, security and reliability of aircraft.

Boeing urges the Commission to ensure that any rules adopted permitting the development of Access Broadband over Power Line ("Access BPL") networks do not result in harmful interference to aeronautical HF communications networks. The *NPRM* not only fails to meet this requirement, it also fails to address the critical importance of aeronautical HF communications and the interference limits that would be necessary to ensure the reliability and availability of aeronautical communications services. The Commission should adopt strict limits on the interference that Access BPL networks are permitted to radiate in aeronautical HF communications spectrum. Alternatively, the Commission should require Access BPL networks to "carve out" spectrum segments allocated to aeronautical HF communications services.[1]

II. AERONAUTICAL HF COMMUNICATIONS NETWORKS PROVIDE ESSENTIAL PUBLIC SAFETY, SECURITY AND RELIABILITY FUNCTIONS FOR THE AVIATION INDUSTRY WORLDWIDE

Aeronautical HF spectrum provides essential communications services for Boeing and the entire aviation industry. Aeronautical HF communications spectrum is allocated internationally in 21 small spectrum segments between 2 MHz and 30 MHz. In total, only about 2.2 MHz of HF spectrum is allocated for commercial aeronautical communications services, giving the numerous aircraft operating over oceans at any one time few options when they experience harmful interference in one or more HF spectrum segments.

Aeronautical HF communications is a primary, and beyond line-of-sight, generally the only means of communications with aircraft flying over ocean routes, the polar regions, some

[1] Boeing also operates numerous test facilities that are highly sensitive to conducted RF signals that exist on power lines used for Access BPL networks outside Boeing facilities, but are also used to provide electrical services into Boeing's facilities. The costs of adding sufficient power line filters to prevent conducted interference would be substantial.

developing countries and other remote regions of the world.[2] Aeronautical HF communications networks are essential for the safe and efficient operation of aircraft, providing aircraft operators with a communications link with air traffic control centers in case of equipment malfunctions, security disruptions, medical emergencies, unexpected weather and other unforeseen conditions. The importance of aeronautical HF communications networks for homeland security efforts has increased exponentially as U.S. officials seek to ensure that they know the identity of every aircraft approaching U.S. territory and can quickly confirm their proper operation.

Boeing and other aircraft manufacturers and repair facilities use HF communications networks to make long haul deliveries of new and modified commercial and governmental aircraft to customers overseas. Boeing maintains a number of fixed HF aeronautical radio ground stations at its facilities around the United States to remain in contact with these aircraft and help to ensure their safe delivery.

Boeing and other aircraft manufacturers and repair facilities also use HF aeronautical communications networks extensively in the continental United States to perform testing of new and modified commercial and military aircraft, both on the ground and in flight. About 42 KHz of spectrum is allocated to commercial flight test purposes in 14 small spectrum segments between 2 and 30 MHz. Using this spectrum, the HF radio system for each new and modified aircraft is first tested on the ground using a number of different channels. Aircraft are then flight tested to perform a complete systems analysis.

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[2] Aeronautical satellite communications equipment is also installed on many aircraft flying in oceanic and remote airspace. Such equipage is far from universal, however, and HF is still the only means of oceanic, polar and remote area air traffic control authorized by aeronautical regulatory authorities.

During flight testing, HF aeronautical radios provide the only means of communications between the aircraft operator and flight test controllers when the aircraft is beyond line of sight. Flight tests must replicate to the extent possible "real" flight conditions. Therefore, flight test pilots routinely operate the aircraft hundreds or thousands of miles away from the fixed HF aeronautical radio station providing ground support.[3] The availability and reliability of HF aeronautical communications spectrum is essential to ensure the safety of flight test operators and the public on the ground.

The HF radio band is uniquely suited for ensuring essential communications with aircraft because HF signals propagate over very long distances. HF transmissions refract in the ionosphere, permitting them to travel far beyond the horizon.

Unfortunately, these optimal propagation characteristics heighten concerns about harmful interference. Unwanted radiocommunications signals that radiate in HF frequency bands do not dissipate nearly as rapidly as emissions in other frequency bands. HF propagation characteristics are also highly variable as a result of terrain topology, time of day, season, link distance and weather conditions. Furthermore, solar conditions, such as sunspots, continually alter the ionosphere, affecting its ability to refract HF transmissions and potentially reducing the quality and availability of aeronautical HF communications traffic.[4]

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[3] To help ensure the safety of flight test operators and the aircraft, flight tests are almost always performed over land, rather than over the ocean, further increasing the potential for harmful interference from Access BPL networks.

[4] The number and size of sunspots vary in an approximate eleven year cycle and are expected to continue to reduce the reliability of aeronautical HF communications services for the next two years. At the start of a new cycle, although propagation characteristics for aeronautical HF communications are expected to improve, the propagation characteristics for unwanted interfering signals will also improve, further permitting them to aggregate and disrupt aeronautical HF communications.

As a result, aeronautical HF communications networks regularly exchange transmissions over thousands of miles using signals that are marginally above the noise floor. The problem is particularly acute for air-to-ground HF communications. Although, fixed HF stations on the ground generally transmit signals at high power levels, airborne HF radio operators must transmit at far lower power levels, which are often inadequate to close a communications link with the station on the ground.

Terrestrial HF stations attempt to compensate for this imbalance by using large, highly sensitive, omnidirectional and/or directional, receive antennas. The typical terrestrial HF receiver will have a sensitivity of as much as -113 dBm.[5] These highly sensitive receivers are also highly sensitive to unwanted emissions, making them extremely susceptible to harmful interference and disruptions to air-to-ground communications.

Air-to-ground transmissions are often the most important communications for aircraft operators. An aircraft in distress must be capable of initiating communications with officials on the ground to request technical, navigational, operational or other assistance. If air traffic management officials on the ground cannot hear an initial call for assistance from an aircraft, they may be unaware of the emergency in a timely manner to offer assistance.

Because of the critical importance of aeronautical HF communications services, the Commission must ensure that Access BPL systems do not cause harmful interference to aeronautical HF communications networks. Furthermore, the Commission must ensure that operators of HF aeronautical communications networks have an effective means of mitigating

[5] In addition, when operators of HF aeronautical communications receivers are setting up to perform system checks, signal levels as low as -120 dBm are typically checked.

interference when it does occur. As discussed in the next section, the *NPRM* largely disregards these important issues.

III. THE *NPRM* DISREGARDS THE HARMFUL INTERFERENCE THAT ACCESS BPL NETWORKS WILL CAUSE TO AERONAUTICAL HF COMMUNICATIONS SERVICES

The *NPRM* does not appear to acknowledge the potential for harmful interference into essential, safety-of-life aeronautical HF communications services. The *NPRM* mentions aeronautical HF communications only briefly in a short discussion of "other services."[6] The *NPRM* quotes Aeronautical Radio, Inc. ("ARINC") in warning the Commission that Access BPL could "exacerbate interference" to HF communications and

> the FCC should not take actions that would result in any increase in the noise floor in the HF radio spectrum, because any noise increase would inevitably diminish the ability of aviation to maintain communications with aircraft operating over oceans and in remote areas of the world.[7]

Rather than respond to this critically important issue, the *NPRM* appears to disregard the problem. The *NPRM* briefly acknowledges that public safety systems "merit particular attention because of the often critical nature of their communications."[8] In making this statement, it is unclear whether the *NPRM* is making reference to all public safety communications systems, including aeronautical systems, or just terrestrial emergency response and law enforcement communication systems.

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[6] *NPRM*, ¶ 17.

[7] *Id.* (*quoting ARINC NOI Reply Comments* at 3).

[8] *See id.* ¶ 37.

Regardless, rather than give "particular attention" to public safety systems, the *NPRM* dismisses these important services in a single paragraph, stating

> we believe that a properly designed and operated BPL systems will pose little interference hazard to non-amateur services such as aeronautical, maritime and public safety.[9]

The *NPRM* attempts to justify this claim by arguing that "*most* public safety systems are designed so that mobile and portable units receive a signal level significantly above the noise floor."[10] The *NPRM* also indicated that "[a]lthough some public safety systems operate between 25-50 MHz, most pubic safety networks operate above 50 MHz.[11]

The *NPRM* fails to acknowledge, however, that aeronautical HF radios generally operate only slightly above the noise floor using spectrum allocated below 30 MHz to receive critical communications often from thousands of miles away. In this regard, aeronautical HF communications networks operate in a manner far more similar to amateur radio devices than local or regional pubic safety networks.[12]

In analyzing the potential for harmful interference to amateur radio services, the *NPRM* acknowledges that "there is some potential for Access BPL to cause harmful interference to radio services."[13] The *NPRM*, however, concludes that "[o]n balance, we believe that the benefits of

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[9] *Id.*

[10] *Id. (emphasis added)*.

[11] *See id.*, ¶ 38, n.95.

[12] As discussed in the next section, however, HF transmitters on commercial aircraft generally transmit at far lower power levels than amateur radio services and aircraft HF antennas are also less directional than amateur radio antennas.

[13] *NPRM*, ¶ 33.

Access BPL for bringing broadband services to the public are sufficiently important and significant as to *outweigh* the potential for increased harmful interference that may arise."[14]

In reaching this conclusion, the *NPRM* did not take into consideration the significant risk that exists of harmful interference into aeronautical HF radio systems and the serious potential consequences in terms of the loss or disruption of critical, safety-of-life aeronautical communications. Furthermore, the interference mitigation techniques proposed in the *NPRM* are inadequate to protect safety-of-life aeronautical HF communications services. The Commission should therefore carefully investigate these issues before adopting any rules authorizing the operation of Access BPL networks in spectrum allocated to aeronautical HF communications services.

IV. THE MITIGATION INTERFERENCE APPROACHES PROPOSED IN THE *NPRM* WILL NOT PROTECT AERONAUTICAL HF COMMUNICATIONS SERVICES

As discussed above, Access BPL Systems have the potential to cause significant interference to critical aeronautical HF communication systems. Not only did the *NPRM* fail to address this interference potential, but it also failed to consider whether the interference mitigation techniques proposed in the *NPRM* would adequately protect aeronautical services.

Instead, the *NPRM* only proposed interference mitigation techniques designed to potentially help other communications services. For example, the *NPRM* suggests that amateur radio operators can reduce interference from Access BPL networks by refraining from pointing antennas toward sources of Access BPL emissions.[15]

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[14] *Id.* (*emphasis added*).

[15] *See id.*, ¶ 35.

Aeronautical HF receivers, however, do not have this option. Many fixed aeronautical HF ground stations use omnidirectional antennas, which are susceptible to harmful interference from all directions. Other fixed aeronautical HF ground stations use directional antennas, which must be capable of pointing in all directions to communicate with aircraft in different regions. In both cases, HF ground stations use highly sensitive receivers. As explained in a recently released NTIA study on BPL interference, fixed HF stations using "higher gain antennas . . . could face greater risks of interference at lower frequencies."[16]

Emissions from Access BPL networks will also raise the noise floor throughout the HF band, further reducing the ability of aircraft to send or receive communications from HF ground stations and successfully initiate emergency and unscheduled communications with air traffic controllers. Aeronautical HF transmitters on aircraft generally transmit at far lower power levels than amateur radio services.[17] HF antennas on aircraft are also less directional than the yagi (directional) antennas commonly used in the amateur service. As the NTIA study explained, an aircraft traveling above or near an area with multiple BPL devices "could see substantial S/N degradation."[18] Furthermore, "[h]igher or lower densities of active co-frequency BPL units would raise or lower the predicted interference levels in direct proportion to the unit density."[19]

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[16] *See Potential Interference From Broadband Over Power Line (BPL) Systems to Federal Government Radiocommunications at 1.7-80 MHz*, NTIA Technical Report Number 04-213, at 6-15 (April 2004) ("*NTIA Study*").

[17] Commercial aircraft HF transmitters nominally operate with a 400 Watts peak envelop power, which is far less than the maximum power (1500 Watts) permitted for the amateur service in the United States.

[18] *NTIA Study* at 6-20.

[19] *Id.* at 6-24.

The aggregate interference from Access BPL networks is likely to be far worse than the interference created by existing unintentional radiators.[20] This is because existing unintentional radiators are primarily operated indoors and not elevated on poles connected with long wires capable of radiating the signal as interference.

The *NPRM* proposes to permit Access BPL networks to operate under Part 15 of the Commission's rules.[21] The NPRM suggests that such an approach would help to protect other spectrum users by requiring Access BPL networks to cease operations in case of harmful interference.[22]

It would be nearly impossible, however, for operators of HF aeronautical communications networks to quickly identify and shut down specific sources of harmful interference from Access BPL networks. The *NPRM* is not proposing to require Access BPL transmissions to include a readily identifiable signature that would enable victims of harmful interference to quickly and reliably identify the Access BPL equipment causing the interference. Even if such a requirement did exist, it would not help to prevent the aggregation of hundreds of Access BPL transmissions from causing harmful interference to HF aeronautical communications networks, particularly when a victim aircraft is constantly moving.

The *NPRM* speculates that, given the significant investment that would be required to construct Access BPL networks, the operators of such networks "would have a strong incentive to exercise the utmost caution in installing their systems to avoid harmful interference and ensure

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[20] *Cf. NPRM*, ¶ 34 (claiming existing Part 15 devices do not create significant interference).

[21] *See id.*, ¶ 38.

[22] *See id.*, ¶ 39.

uninterrupted service to their customers."[23] Regardless of whether this might be correct, the opposite proposition is certainly true. Once Access BPL networks are operational and serving paying customers, Access BPL network operators (along with the Commission) will be extremely reluctant to shut down Access BPL networks, either on a widespread or limited basis, in response to complaints of harmful interference, no matter how well documented.

Furthermore, a significant likelihood exists that aeronautical HF communications networks could cause harmful interference to Access BPL systems. If this occurs, Access BPL network operators will have considerable incentive to urge the Commission to modify its rules so that Access BPL networks will no longer be required to accept harmful interference from licensed communications services operating below 30 MHz.[24] It is therefore inappropriate, as a public policy matter, to permit Access BPL networks to operate under Part 15 of the Commission's rules.

The *NPRM* also proposes that Access BPL systems should be required to employ adaptive interference mitigation techniques, such as reducing power, carving out frequencies and shutting down offending systems.[25] None of these approaches, however, would prevent harmful interference to aeronautical HF communications.

As the *NPRM* acknowledges, such capabilities would only help to resolve "localized and site-specific harmful interference."[26] In contrast, aeronautical HF communications involve facilities communicating at great distances in a variety of directions on a real time basis.

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[23] *Id.*

[24] *See* 47 C.F.R. § 15.5 (2003).

[25] *NPRM*, ¶¶ 40 & 41.

[26] *Id.* ¶ 40.

It is also impractical to expect an Access BPL network operator to reduce power levels, carve out frequency bands, or shut down operations on a network in sufficient time to restore communications between a specific aircraft and a specific fixed HF receive station on a case-by-case basis. Even if such a capability did exist, in most cases, fixed HF station operators would be unaware that harmful interference from one or more Access BPL systems was preventing an aircraft from contacting them. As a result, the fixed HF station operator would be unaware of the need to request the Access BPL network operator to mitigate the emissions. When critical information needs to be communicated over the public air waves, it is not in the public interest for the Commission to permit such a condition to exist.

The option of carving out individual frequencies on a case-by-case basis would also be inadequate to prevent harmful interference to HF aeronautical communications networks. Fixed HF stations need access to all allocated aeronautical HF frequencies in order to identify communications channels on a "real time" basis that are unencumbered by other communications traffic or excessive ambient noise.

Finally, the *NPRM* proposed to require Access BPL systems to participate in a notification system in which they must file detailed information regarding their planned and operational Access BPL networks with an industry-operated entity.[27] The *NPRM* proposed that such information would be made public to interested parties.

[27] *See id.* ¶ 43. The *NPRM* also queried whether Access BPL operators should be permitted to maintain their own databases. Such an approach would further aggravate the difficulties in identifying and resolving cases of harmful interference by establishing numerous, potentially incompatible databases, which would have to be searched individually by primary spectrum users in order to resolve harmful interference disputes.

For the reasons discussed previously, however, such a public disclosure process would be inadequate to prevent repeated incidents of harmful interference, or provide an adequate vehicle to ensure their cessation. It will be nearly impossible to identify sources of Access BPL interference absent the use of a readily identifiable signature enabling victims of harmful interference to identify and contact the Access BPL operator or operators that are causing the interference.

Instead, the Commission must investigate fully the potential for interference from Access BPL networks into HF aeronautical communications systems and develop techniques to prevent harmful interference and protect vital aircraft communications services. Such efforts should be done with the active participations of aeronautical spectrum users, such as Boeing, ARINC and transoceanic airline operators. Alternatively, the Commission should ensure the availability and reliability of HF aeronautical communications systems by requiring all Access BPL networks to refrain from using any spectrum segments that are allocated to aeronautical services between 2 and 30 MHz.

V. CONCLUSION

For the reasons stated herein, the Commission should refrain from authorizing Access BPL networks until interference limits are developed that are adequate to protect fixed and airborne safety-of-life, HF aeronautical communications services. Alternatively, the

Commission should require BPL networks operators to carve out all spectrum allocated to aeronautical services between 2 and 30 MHz.

Respectfully submitted,

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